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Engineer — Sell Yourself

Soaring in the Clouds

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Above: *From an old photo of lower Broadway at John St., New York about 1890.* **Right:** *Actual size of 150 pair cable.*

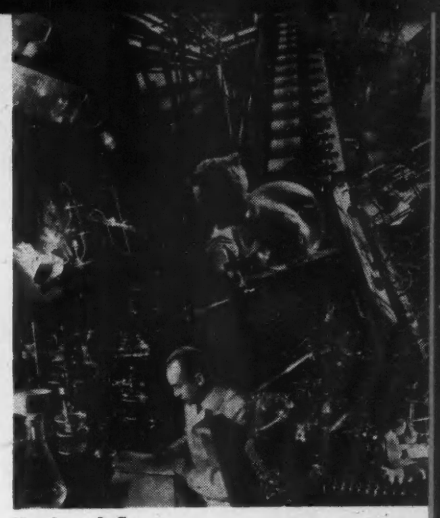
Bell System engineers long ago began to work out a way to clear city streets of overhead wires. The first telephone cables were crude affairs—a few wires drawn through a pipe. Continuous research brought forth improved designs, better manufacturing methods, cables of smaller size yet far greater capacity. The cable with the greatest number of wires today—3636—is 2⅝″ in diameter.

More than 94% of the Bell System's wire mileage is now in storm resisting cable—one of many developments to improve service.

Why not drop in at home tonight — by telephone? For a lot of pleasure at bargain rates, call by number after 8:30 P. M.

BELL TELEPHONE SYSTEM

THE TECH ENGINEERING NEWS



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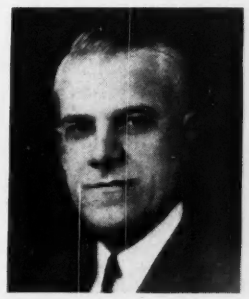
FLOWING FLAME

ENGINEER — SELL YOURSELF!

By T. RUSS HILL *
Vice-President in charge of sales
Air-Way Electric Appliance Corporation



ONE year ago, we were in an automobile factory in Detroit looking over the new cars. We tried some out and were astounded at the improvements that had been made. As compared to our four year old model, these new glistening streaks were overpowering. We remarked: "You have made marked advances in your cars." Our friend replied: "We have had nothing else to do for the past three years except to improve our cars." By focusing all their attention upon construction and designing improvements, the industry had lifted itself out of the depression. For the past year the automobile producers have led the way in improvement for all fields. It seems that they will repeat it this year. In the main, this may be attributed to the engineers of those companies who either had some ideas about selling or else were able to absorb such ideas when they were thrown at them. There is a great future for any engineer who can sense what the people want and build it for them. The next best thing is to be willing to listen to those who can interpret human desires to you and then build what they want. If we had one piece of advice for any engineer in the commercial field it would be to forget everything that has ever been done in his field and, with an open mind, face today with its sizzling new possibilities. John Cowper Powys wrote: "Culture is what is left over after one has forgotten all he definitely set out to learn." That definition could be applied to the successful engineers who build for others to sell or to sell themselves. By forgetting the beaten paths they blaze the way to new accomplishments.

Engineering is largely a matter of ideas. So is selling. Give a salesman an idea and if he is sold on it, he will succeed by it. Offer the public what they can not resist buying and you will, of course, succeed. So the engineer that has the smack of the proper idea will provide the salesman with that urge which in turn sways the public fancy toward first one product and then another. This is not as easy as it sounds for either profession but it is essential. There never was a time when the field was riper for such development. One of our greatest transition periods is now upon us. Stream-lined, air-conditioned trains; all-wave radios; transparent fountain pens; smaller cars with larger sales appeal; blue evening clothes for men and glass evening gowns for women all speak about a world that is crazy for new ideas and some one to sell them to them. The engineers will serve that public best by mixing with it. Mr. Knudson, who climbed from an immigrant boat to his present position with General Motors, came all that way on his engineering skill. He will tell you today that he always mixed with the salesmen of his organizations and that his ideas came from them. From them he caught the pulse of the public and, in his laboratory, he answered the demands manifested by that pulse.

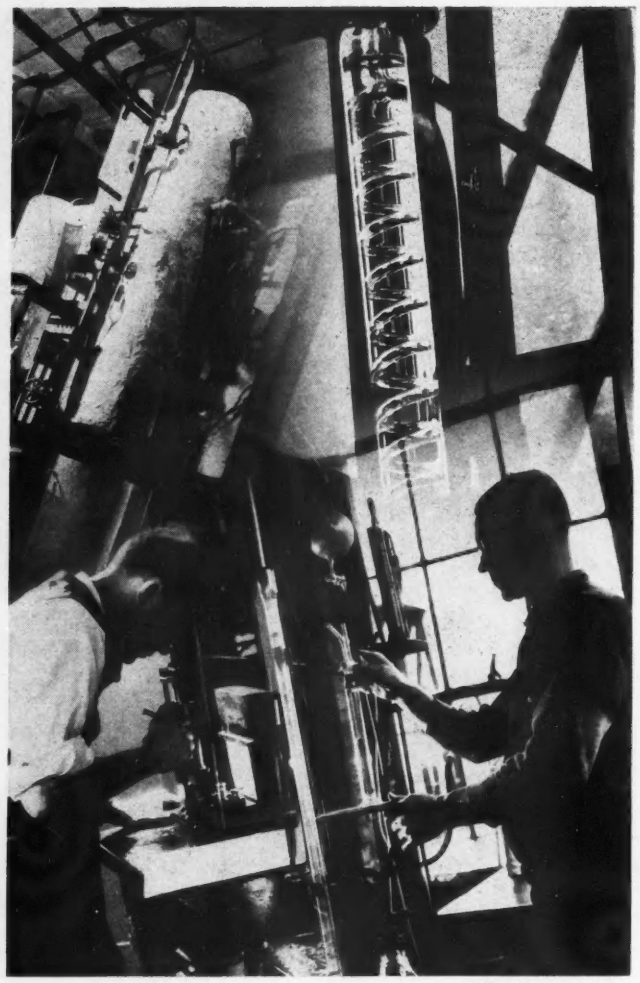
Without knowing it, probably all successful engineers are salesmen. That might be said of any successful man if you stretched the definition far enough. It is more true of the engineer. Given the idea, he has to produce it himself, sell it to a producer, or employ some one to do the selling for him. Edison covered a lot of territory before he finally sold the incandescent light to a lamp and candle burning world, but he sold it and today the national government is frantically busy making that lamp and what has come after it possible for every home in the land, even the most humble. Fulton's idea took hold after many failures and it was sold by the producer. Bell had to endure the jeers of an average Congress before he finally sold his idea that advanced business and civilization a century in one jump. The machine that the Wright brothers first flew hangs in a British museum, mute testimony of how far they had to go to sell their idea which jumped the world's progress another one hundred years and bound the earth into a community. Ford found a few weak souls that would venture a little way on his idea and within a span of one-half of a generation we have seen that idea blossom into our greatest business. Ripley, Winchell, Lowell Thomas, Amos and Andy—all these had ideas and they sold them, but behind them stands an engineer searching for new fields. He, too, sold his idea.

It is not unusual for young men to imagine that the world is all finished. Read Charles F. Kettering's article

*** T. Russ Hill is the Vice-President and Director of the Air-Way Electric Appliance Corporation. In this capacity he is in complete charge of one hundred factories and a force of over five thousand men. Mr. Hill entered Air-Way in 1929 and has risen successively through the positions of salesman, branch manager, zone sales manager, general sales manager, and, in 1932, vice-president in charge of sales and director of the corporation. Previous to 1929 Mr. Hill was the president of a wholesale sales corporation, which he had established ten years before, and which then did a $2,000,000 business annually.**

In college Mr. Hill was valedictorian of his class and a letter man in three sports. Upon graduation he taught school and in the period of three years advanced to the position of a superintendent. During the World War Mr. Hill joined the Aviation Corps and upon his return embarked upon his business career.

Mr. Hill is in much demand as a speaker with the RKO circuit. Former positions of president and national councillor of the Chamber of Commerce bear further witness to Mr. Hill's ability and experience.



Gasoline Products

Behind every successful product — ceaseless research.

"The World Isn't Finished Yet." Perhaps you did when it ran in *The Saturday Evening Post*. He is General Motors' eminent engineer. The article will stir you to the roots not only with the swiftness of time but its changeableness. Nothing that man has made is fixed today. Mr. Cameron, spokesman for Mr. Ford, recently said that the machinery in the Ford building at the World's Fair last year was obsolete before the Fair was over. No sensible man plans today for more than a few days. You may erect large buildings and project gigantic programs for some article that may be obsolete before the roof is on the buildings or the ink has dried on the written plans. No one can plan twenty-five years ahead. How do we know what people will desire then or what they will consider unusual or appealing? They may look upon the airplane and the radio as we look upon hand printing presses. It has not been much more than that long since we thought the horse and buggy were quite the thing and never even dreamed of listening to addresses as they were delivered across the seas. There are searchers in the laboratories today who are going to vault clear over the heads of present-method producers and they are going to do it in one leap. One cannot imagine what their contributions will be like, but one can hope to be here twenty-five years hence and see just what is extraordinary then. The engineer with the selling sense will write the answer to that query. He has a head full of ideas and a bench loaded with mechanisms. None of these have quite clicked yet. In other words, they do not have commercial value but perhaps tomorrow, or within the next hour, his research will uncover something that will make them commercially valuable. Then the task is through so far as that item is concerned, but he must begin to blaze new paths that will be ready when that one he has just marked is obsolete. Sensing human wants and human desires, supplying articles that create desires, playing to the restlessness of our people, keeping in the forefront of rapidly advancing businesses—that is a great challenge, and upon the backs of people who understand salesmanship will the answer to it be carried forward.

In the beginning, we admonished you against sticking to the guide-posted roads. We are convinced that successful salesmen are men who have learned what is their greatest asset and have commercialized upon that one asset vigorously. We believe the same applies to engineers. Certainly it does to those who engineer for sales purposes. By giving our main talents their head, we find that we climb the hills of achievement. By imitating or poking in old excavations, we flounder on the edges of success and catch a few sparkles from those that scintillate before us. Can you imagine Al Jolson singing Grand Opera or Rosa Ponselle putting over a red hot Sophie Tucker song? How far do you think Lincoln would have come out of the backwoods of Illinois by having his hair marcelled, wearing white spats, and putting a carnation in his lapel? How long would President Roosevelt hold the masses if he hid his famous smile behind a monocle, carried a cane, and threw a few "donchaknows" at the public? These people were salesmen from the start, but they were wise enough to follow their own bent. Wrapped up within the youth of today are ideas with possibilities that would startle their professors. By following their own lines of thought, those chaps are going to uncover those ideas and some of them will move the world forward another one hundred years in one leap. Some people are afraid of new paths or new ideas. Naturally they always follow the leader. They aren't salesmen in any line. They are order takers and crumb pickers, actually and intellectually. They have always seen things done one way and they are going to keep on doing them that way. Anything else is heretical. Well, selling has gone through as great a change in the past four or five years as any line of endeavor. We even believe that the change has been greater there than in any other line. Only those remain who have abandoned the sinking ship and struck out for themselves. Some excellent new courses have been developed. Some new leaders have been uncovered. Perhaps the engineer would contend that his field has seen the greatest transition. The two fields are very close together, but what has happened is only the beginning. The man who can step from these new ideas to still newer ones is the man of tomorrow and by tomorrow we do not even mean ten years hence.

Ever hear of Diamond Brand Rattle Snake Meat? Men have been killing rattlers as well as other kinds of snakes ever since Adam and Eve ran amuck with one in the Garden. There is a packer in the South that kills them, too, but not until they are nice and fat. Then he cans them. Last year he sold over one million dollars worth of that meat under the above brand. He thought it was all right to kill rattlers, but why not be paid for the expended energy? It took at least 2000 years to produce a man who would ask himself that question and answer it. The snakes have been here all the time. Man had to match that natural supply with a process that made it of commercial value. Petroleum has been with us for some time. Man had to find a way to change its form so that it became highly commercial and then he went on to develop equipment that would use more of the fluid he had refined. The silk worm has been spinning silk for centuries. Man now makes better silk than the worm does. A commercial idea turned that

trick. Tomatoes, grape fruit, oranges, prunes were seasonable items until some one got a new idea that could be sold. Now the juices of all these and many more fruits and vegetables are canned and bottled and sold the year around to the public that has already been educated to the value of the ingredients of those juices. Every one of these ideas and the hundreds more that might be mentioned took selling on the part of some one. Many times it was a combination job. The man that perfected the process started the sales talk and it ended up in the columns of some paper or magazine and on the floors of the stores of the country.

Clive was in a rut. He knew it. He was a clerk. He did the same thing every day and in the same way that it had been done for years and years. He had ambition. He wanted to swing through wider orbits. He failed to use his head, however, and ran afoul in his thinking. He tried to commit suicide but the gun would not fire. Finally, he took into account all the known facts and then tried to blaze a path into the unknown. He tried a new field. He enlisted in the army. He stayed away from the routine office work to which he was adapted. He got out on the firing line. This step finally added India to the possessions of his country, raised him to the peerage, and wrote his name into history as a daring, rash adventurer that followed none of the rules of the game. He was an engineer of new ideas and a salesman of them, as well.

The present seems to be a good season for dictators politically, but do not make the mistake of imagining that the same holds true in business or in the field of research. You may create the demand for something, but not unless it uncovers, within the person who is purchasing it, a desire to own it that may have been dormant until it was called to that person's attention. There may be a few salesmen that are powerful enough to sell straw hats to Eskimos and fur coats to South Sea Islanders but their course is soon finished. The product that approaches meeting a universal need with a full degree of service is the one to tie to. Such products spring from the minds of engineers who are conscious of the ideas of others. They are sold by salesmen who have the viewpoint of the prospect as applied to that product. Do not make the mistake of becoming so attached to preconceived ideas that you force them upon all whom you meet. We have seen many companies with bright futures wrecked upon the rocks of poor engineering and ill management. In many instances, the catastrophes could have been avoided had the executives been willing to heed the suggestions that were borne into the office from the highways of the field. The only cue worth following is the one that has come from the practical man who produces practical results. To be sure, these ideas have to be squared with the technical formulas for constructing the product. It is much easier to bend the inside to the outside than it is to perform the reverse operation. We have always found it much better to sell the people what they want to buy than to try to make them buy what we think they ought to have. The recent prohibition experience was an apt illustration of that fact. The engineering profession usually moves forward upon that simple truth.

Frankly, we envy the engineers of today. Their field is so unlimited and the outlook is so brilliant. We would not exchange selling for any other phase of this rapidly moving day, but we do long to step behind the scenes and see what is going on. It seems that ideas are bursting like a fireworks display. Improvements are coming with the swiftness of a shooting star. It keeps us busy training our sales forces on the new improvements that are perfected with our own equipment. No sooner do they get set with one than another is dumped into their laps. Back of all that, is the engineer who has caught the pace of this new movement that is rapidly taking hold of the country and whirling it forward. These next few years are loaded with possibilities. In fact, the next ten years will in all probability surpass the past twenty-five in advancement. The next six years will see new fortunes made and new levels in distribution reached. We have only started to supply the world with what it will take, regardless of the fact that we are fearful of the mass production that was ushered in during the "twenties". No markets are saturated and those that appear to be are only waiting for some new advancement in that field to come forward and replace all the present equipment. Shelves have been emptied in the past few years in all lines and, in addition to that fact, obsolescence has set in on every hand. The wheels are beginning to turn at new speeds, the smoke is belching from the chimneys, and the thousands of idle people are beginning to shake themselves and increase their pace from that of the bread line to that of the bread winner. Natural forces are exerting themselves. Salesmen are at work with a new enthusiasm and they have better wares to offer than ever before—thanks to the engineers that have been digging for the past few years in order to tunnel their concerns out of the holes into which the depression had hurled them.

Into this unlimited field, step you engineers of today to become the leaders of tomorrow. Analyze carefully what the trends in the selling fields are. Live as closely as possible with the practical salesmen and with the customers he serves. Do not be afraid to wander in the forests that have not been explored. Waste no time tinkering with anything that has become commonplace regardless of how good it may be now. Know yourself and particularly what there is in your mental equipment that has at least an even chance with your competitors and then develop that one thing intensely. Do not become convinced easily but once you are, have the courage of your conclusions. Believe in the possibilities of today. You can. Above all else, know that you will always be successful by creating for the use of the people that which they cannot resist buying.

General Electric

Lipstick containers and cosmetic jar of molded plastic, engineered for sales appeal.

Accounting for

ENERGY IN RADIATION

— *Solar Power*

By GORDON B. WILKES '11
Professor of Heat Engineering
Massachusetts Institute of Technology

SINCE the very beginning of human life upon the earth, man must have been intensely interested in our greatest source of heat radiation, the sun, and it is not surprising that it frequently became a subject of worship.

The quantity of heat energy delivered to the earth from the sun is many times greater than all of the energy developed by our great power plants and hydroelectric developments combined, but even this huge amount is only a tiny fraction of the total energy radiated from the sun in all other directions. The amount of heat energy received on the surface of the earth at noon on a clear day, allowing for atmospheric absorption, is approximately 5000 horsepower per each acre of land near the equator. Sir John Herschel, who conducted many experiments on solar radiation, made in 1837 the interesting comparison between the total radiation from the sun with that required to melt a rod of ice. Recent calculations indicate that if there were an infinitely long rod of ice, 22.6 miles in diameter, proceeding toward the sun at the speed of light, 186,000 miles per second, the heat required to melt this ice as it reached the sun would be equivalent to the normal quantity of heat radiated from the sun.

One of the earliest attempts on record to produce high temperatures from solar radiation will be found in the legend of Archimedes, in which he set fire to the fleet of Marcella at Syracuse in 212 B.C. by focusing the sun's rays with flat mirrors upon the wooden ships anchored near the shore. In 1747, Buffington, a French naturalist, set fire to a plank of tarred wood at a distance of 150 feet by means of flat mirrors in an attempt to check the possibility of Archimedes' feat.

John Ericsson, well known American inventor and engineer, devoted twenty years to the problem of utilization of solar energy, constructing many solar engines and spending in the neighborhood of $100,000 of his own money. In connection with this work, he developed the hot air engine which he hoped might be more effective than the steam engine used by nearly all solar power investigators. Apparently this was not particularly successful and his solar energy work might be termed a financial failure by itself, but it has been estimated that the monetary return from his hot air engine, which was very popular before the advent of the gasolene engine, was many times the amount spent on solar energy recovery.

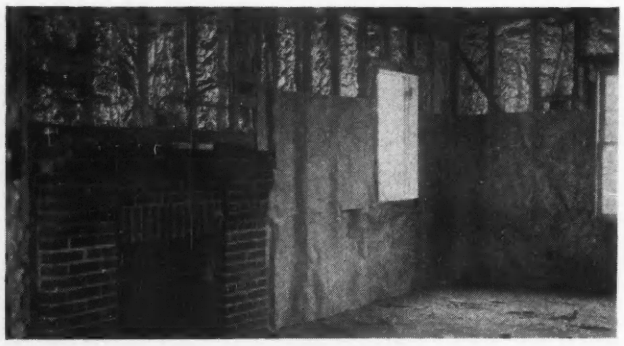
The largest and most practical of all solar engines to date is the one constructed by Shuman-Boys in 1913 at Meadi, Egypt. This consisted of five channel-shaped reflectors of parabolic cross section, each being 205 feet long and about 13 feet wide at the open top. The boiler which was placed in the focus of these reflectors, made steam for a 100 horsepower engine which was used in pumping water. The reflectors were mounted in such a way that they were always automatically turned to face the sun and it was found that over the greater portion of the day the energy absorbed was nearly constant. The greatest power developed from this engine was 55.5 horsepower which indicates an overall efficiency of 3.5 to 4.0% which may seem rather low until one realizes that the modern steam engine has an overall efficiency only three or four times as large.

Many experiments have been made upon cooking with solar heat, the best known one being operated by Dr. C. G. Abbot near the top of Mount Wilson, California. In this cooker, the heat radiation from the sun is focused upon a pipe containing oil, by means of a paraboloidal mirror of aluminum. The pipe is tilted so that it is parallel to the axis of the earth and both ends are connected to an insulated storage tank at a higher level so that the oil, when heated by the sun's rays, rises to the top of the tank and is replaced by cooler oil from the bottom. Two cooking ovens are surrounded by this oil and temperatures of 357° F. have been maintained which are sufficient for many ordinary cooking operations. An occasional cloudy day does not materially affect this cooker on account of the large thermal capacity and good insulation.

Hot water for domestic purposes has been provided by solar heat for many years in various parts of the world such as California, Florida, and tropical countries. Only last summer, I built a solar hot water heater on the roof of my camp in New Hampshire, and on warm sunny days the temperature in a thirty-gallon storage tank reached 140° F. This merely consisted of a coil of blackened copper tubing placed in an insulated box with a glass cover and connected to an insulated storage tank.

We are all familiar with the old experiment of setting fire to a piece of paper with a lens and sunshine. Recently solar furnaces have been constructed by concentrating large quantities of solar radiation on a small area, and temperatures high enough to melt steel have been produced.

The well-known fact that frost frequently forms on blades of grass, with air temperatures well above the freezing point, indicates that the surface of the grass blades must have been cooled to at least 32° F. The grass obviously could not have been cooled by convection from the sur-



"Alfol" insulation reducing heat loss through wall by decreasing radiation.

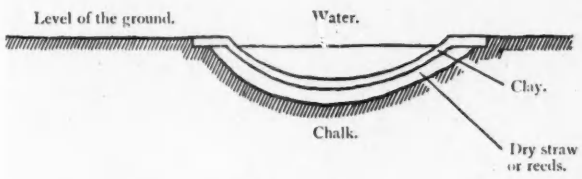
rounding air, nor by conduction of heat to the ground because both the surrounding air and the ground are at a higher temperature than the freezing point. Cooling by evaporation is also eliminated in this case because the blades of grass gain in weight when frost is formed, and the only means of cooling left is that of radiation of heat to the atmosphere above.

For many centuries man has attempted to utilize this cooling effect of radiation to the atmosphere. In India ice was produced on a sufficiently large scale to make it commercially practical by filling large numbers of shallow pans with water and exposing these to the sky at night. These were insulated from the ground by straw so that when heat was lost by radiation, it was not absorbed from the warm ground. In many parts of the world where the air temperature never reaches 32° F., ice has been known to form on shallow ponds.

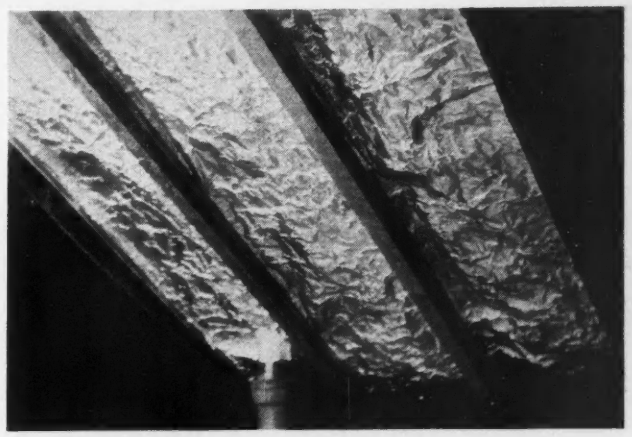
The dew pond in England is an excellent example of cooling by radiation. This type of pond is constructed by making a shallow dish-like excavation in a locality where no water is available. The average diameter of this hollow is probably between 50 and 100 feet and apparently, the larger the better. This is lined with straw or other dry insulating material and then a special clay coating is applied which is impervious to water and must cover the entire area. At night dew will usually form on this clay because of the cooling of its surface by radiation and, finally, the entire hollow will be filled with water as the evaporation by day is apparently less than the gain at night. These dew ponds have been in use for hundreds of years and they continue to supply water even though no rain may fall for weeks.

Modern applications of radiation take advantage of the fact that all materials are radiating, absorbing, and reflecting heat energy while some also transmit this form of energy. The radiating, or emissive power is dependent primarily upon the nature and temperature of the surface involved. The absorption and reflection are dependent upon the nature and temperature of the radiating source as well as the nature and temperature of the surface. The transmittance of heat radiation is dependent upon the nature and temperature of the material itself as well as the nature and temperature of the radiating source.

Much confusion concerning the relative radiating, absorbing, and reflecting powers of various surfaces exists because many do not realize the factors that affect these phenomena. For example, at room temperatures (and this may be extended to steam temperatures) black and white paint radiate heat equally well. Thus, as far as radiation alone is concerned, it makes no appreciable difference what color a person paints his domestic steam radiator. Aluminum and bronze paints radiate heat less readily than oil paints, but this also has little effect on the heat loss from radiators. The "radiator" is usually constructed in such a way that the majority of the heat is lost by convection rather than by radiation and this mode of heat transmission is not appreciably affected by the surface coating. The bulk of the energy in the radiation from such sources is in the far infrared region with the wave length of maximum energy being equal to approximately 9.3 microns.



The dew pond. A practical method of cooling by radiation.



Insulation by heat reflection with thin aluminum foil in the roof.

On the other hand, if one exposes black and white surfaces to solar radiation, the reflectivity of the white surface will be many times that of the black. In this case the two surfaces in question may be at room temperature but the source of the radiation is at a very high temperature and the wave length corresponding to maximum energy in solar radiation is much shorter, namely 0.4 micron.

The table below will illustrate how the emissivity of three surfaces at room temperature will vary with the temperature of the radiating source.

	Emissivity (reflectivity) of Surfaces when exposed to sources of radiation at different temperatures	
	100° F.	5,000° F.
Lamp Black Paint	96	97
White Paint	89	8
Polished Aluminum	5	26

A year or so ago, a newspaper item described how men coated the surface of the ice in the Yukon River, Alaska, with black oil in order to hasten the melting in the Spring and thus open navigation. There is no doubt but that the oil coated surface absorbed more radiation from the sun than snow covered ice.

When Prof. Piccard made his first trip into the stratosphere he knew that the temperature at a height of 10 miles, would be in the neighborhood of 60 to 70° below zero Fahrenheit. He also knew that the transfer of heat from his aluminum gondola would be almost entirely by radiation since the convection losses would be slight, as he would be travelling with the wind, and the conduction loss would not be great through the air. He also knew that during the day time the sun would be shining since there are no clouds in the stratosphere. Consequently there was available a cheap source of heat. He painted the gondola, half black and half white and devised a rotating mechanism by which he could turn either the black side toward the sun and have the effect of a steam heated roof or the white side toward the sun and reflect most of the solar radiation. When he reached the stratosphere, the temperature inside of the gondola rose from 70 to 80° F. with an outside temperature of —60° F. and approximately 1/8" of aluminum between these temperatures. As it became uncomfortably warm in the gondola, he attempted to operate his

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Principles of
MODERN SOARING FLIGHT
— Gliding in the Clouds

*By JAMES B. KENDRICK '34 **
Massachusetts Institute of Technology

Illustrated by the author

THE development of gliding and soaring presents an amazing history of progress in design and technique. Since 1921, when German flying enthusiasts first began a concerted study of gliding as a sport, there has been a constant and rapid improvement in performance, which may be effectively shown by a short tabulation of record performance flights, as recorded for various years up to the present.

	1922	1927	1931	1935
Duration...	21 minutes	8 hours	14 hours	36½ hours
Altitude ...	500 feet	1000 feet	8500 feet	12,000 feet
Distance....	5 miles	13 miles	90 miles	233 miles

That these records will continue to improve seems certain from the fact that sailplanes capable of making better flights are at present awaiting the proper conditions, or are in the process of being constructed.

What is meant by "proper conditions" for a record sailplane flight, and why is there such certainty that better sailplanes can be built in the future? First, how is it possible for a heavier-than-air motorless plane to remain aloft at all? Referring to Fig. 1a, an airplane without power, flying in still air with the speed V, will naturally glide downward toward the ground, and eventually have to land. The rate at which the plane descends is equal to the downward component of its speed, or to the sinking speed Vs, measured in feet per second. (The minimum sinking speed of modern sailplanes is somewhat less than two feet per second.) If, as shown in Fig. 1b, the upward velocity of air in which the plane is flying is greater than the sinking speed, a gain in altitude may result, and sustained flight, or soaring, will be possible.

Certain meteorological conditions giving rise to upward velocities in the atmosphere are utilized by the soaring pilot in making a flight. A few of these conditions are shown in Fig. 2. "Ridge soaring", (Fig. 2a) perhaps the simplest of all soaring manoeuvers, is accomplished by flying in the upcurrent which results from wind blowing up the side of a hill, or range of hills. "Thermal soaring" (Fig. 2b and c) is possible by circling upward in the air rising over a heated portion of terrain.

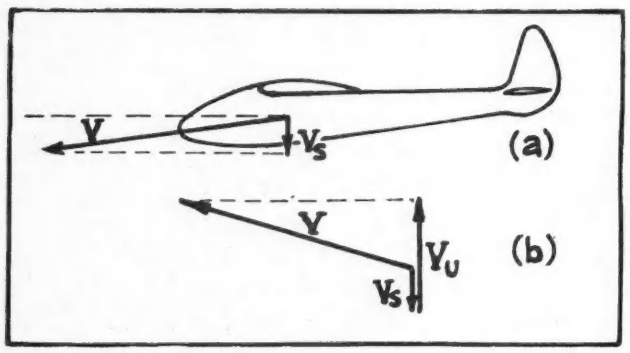

Fig. 1. Velocity components of the sailplane in flight. a. In still air. b. In upward air currents.

Suppose it is a hot summer day—not a cloud in the sky—the sun's rays are beaming down on a section of comparatively flat country. Some portions of the ground will absorb less of the sun's heat than those adjacent; the air over these portions will become hotter than the surrounding air, as in Fig. 2b, and at frequent intervals an air mass will start to rise. The adjacent air will close in to take its place, and a "thermal", or rising column of heated air, will result. (Fig. 2c.) The heated air mass which began the ascent will rise until it has cooled sufficiently to be in equilibrium with the surrounding air, at which time the energy of the thermal will be spent, and the upcurrent will cease. Soon after, in perhaps ten or twenty minutes, the process will repeat itself. A soaring pilot, on entering a thermal while flying across a section of open country, will feel a "bump" and will note that his sailplane begins to rise. He will then attempt to circle within the upcurrent as long as it may continue. Remembering that thermal currents are invisible, one should take off his hat to the pilot who has made a cross-country flight on thermals, for he is a man with his full share of courage and love for action. He is a keen observer, who can choose fields over which upcurrents may occur; judge the effect of the wind, which may tilt the thermal downwind from the field which causes it; and quickly sense the size of the upcurrent and plan his circling manoeuver.

"Cloud soaring" means the use of upcurrents attendant with cumulus clouds for gaining altitude. Normally, the temperature of the air decreases with altitude according to the adiabatic lapse rate (three degrees Fahrenheit per 500 feet altitude). A volume of air rising from the ground will expand and cool according to this rate. On days when the sun's heat warms the earth sufficiently, the air adjacent to the ground will be relatively hotter than at higher altitudes, and the decrease in temperature with altitude will be greater than the normal adiabatic condition. This is known to meteorologists as a "superadiabatic lapse rate", and denotes an unstable condition in the atmosphere, for a volume of air, on being started upward in some manner (by a thermal, or by wind blowing up a slope), will be warmer than the surrounding air, and will continue to rise higher and higher. Upon rising, the air will cool, and at the temperature corresponding to the dew point, will condense into cloud formation. The region beneath a cumulus cloud in the process of building up is therefore an upcurrent region. As one approaches the base of the cloud, the upward velocity will increase. Within the cloud, upcurrents of fifteen to thirty feet per second may be found. However, as one may judge from the fluffy appearance of cumulus

* The author is indebted to Dr. K. O. Lange, of the Meteorology Department, for advice and suggestions concerning the meteorological phenomena described herein.

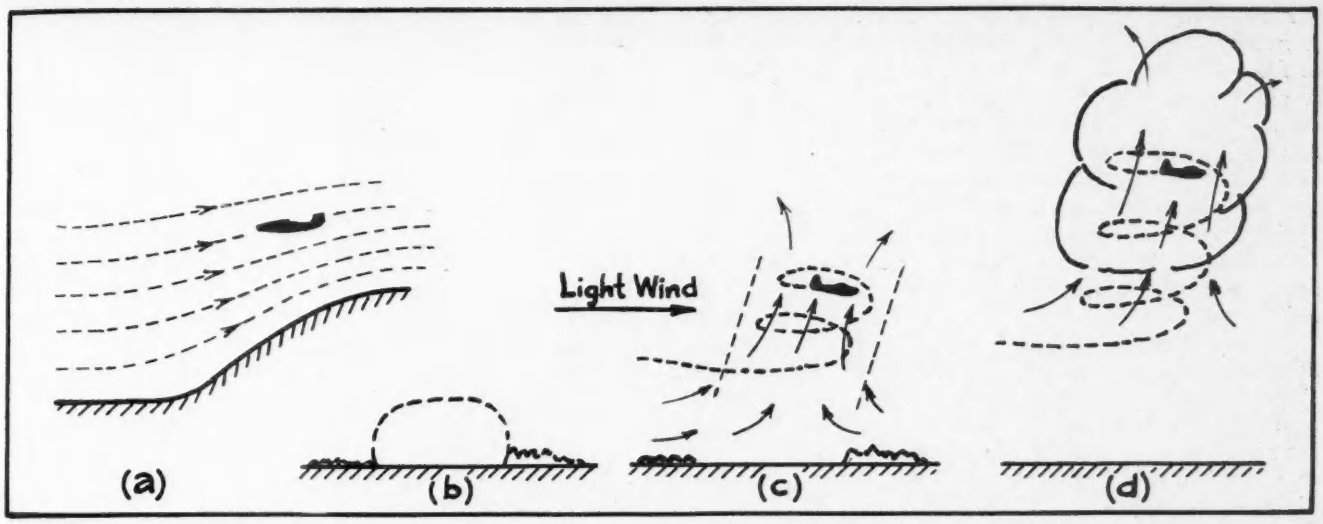

Fig. 2. The sailplane pilot makes use of every available upward air current whether it be produced by ridges, warm spots, or cumulus clouds.

clouds, they are not merely rising columns of air condensing into water vapor, but are very turbulent masses in which strong up and down currents exist. This, together with the fact that a cloud is quite as impenetrable to sight as a thick fog, makes cloud flying an art only to be attempted by able pilots in strongly constructed planes.

Cumulus clouds usually form down wind from some particular section of the terrain which provides the initial impetus for the upward movement of air. A most interesting and instructive study is to watch the growth of a cumulus cloud, starting from a small wisp of cloud, developing into a large fluffy mass, gleaming white and darkly shaded in the sunlight, and finally dissolving or becoming broken up by the wind. The entire cycle of growth and decay may last for only fifteen or twenty minutes. Soon another wisp of cloud may appear in approximately the same position as the first, and another cumulus will build up.

"Frontal soaring" has been used as a means to travel long distances across country. The meteorological term "cold front" denotes the boundary between a large mass of cold air, moving across the country at a fairly constant rate, and the warmer air which lies in its path. The passage of a cold front is a sight familiar to all, though the name may perhaps be unfamiliar. The day may be comparatively fair, with a few high altitude clouds stretching across the sky. The cloudiness may increase somewhat, just before the front is seen on the horizon. Then the front may appear (usually from the west), a long low mass of dark clouds, moving steadily towards the observer. Squally weather, with frequent showers, lasting from a few minutes to several hours, usually follows the passage of a cold front. A cross-section of a typical cold front is shown in Fig. 3. The cold air mass displaces the warmer air upward, and provides an excellent upcurrent in which to soar. Flying ahead of the storm as it moves cross country, a pilot may travel hundreds of miles before landing.

"Ocean thermals" may in the future provide the means for long distance flights across water. This phenomenon generally occurs at night and in the early morning in warm latitudes, when the water may be warmer than the air, and produces an instability in the atmosphere, causing cumulus clouds to form.

The sun provides the energy for the formation of cumulus clouds. In the case of land thermals, this energy is expended during the day, whereas for "ocean thermals", the water stores up the energy, to release it at night when the air has cooled by radiation. The fact that ocean thermals may form at night, and land thermals in the day time is a fortunate circumstance which may make it possible to continue soaring after sundown, and thus materially increase distance and duration performance.

Alto-cumulus clouds sometimes form at an altitude of approximately 12,000 feet. These formations, caused by unequal temperatures in the upper air, have been utilized with good success by German soaring pilots. A sailplane may be towed by airplane up to the level of the alto-cumulus, there to be released and to make its own way on the upcurrents which exist in the clouds.

The upcurrents just described provide the most common sources of power for the performance of soaring flights. The conditions most favorable for duration, altitude and distance flights, and the principle requirements for sailplanes to be used for these purposes may now be discussed. Duration flights are almost always made on ridge currents. If the wind blows up a slope continuously for a number of hours, the pilot must fly back and forth along the slope to make a duration flight. The choice of a soaring site where a continuous wind, day and night, is to be found; a sailplane with sinking speed sufficiently low that it will not be forced down during one of the occasional lulls in the wind; and a pilot who can remain awake for a long period; these seem to be the requirements for new duration records.

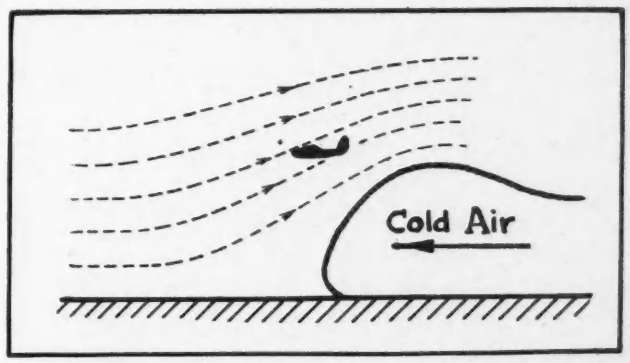

Fig. 3. The cold air mass displaces the warmer air upward, and provides an excellent upcurrent in which to soar.

Altitude flights may be made in large cumulus clouds, or in the upcurrent regions ahead of cold fronts. Altitudes of from fifteen to twenty thousand feet are quite possible to attain under proper conditions. For such flying, sinking speed is no longer important, but the sailplane should be sufficiently strong to withstand the terrific buffeting it may receive in the turbulent clouds, and sufficiently stable that the pilot will have no difficulty with the control while "flying blind" in the clouds. The meeting of these requirements, together with favorable weather conditions, and a pilot in readiness for a flight, may result in new altitude records.

Distance flights may be made by the use of storm fronts, as previously described, and it is believed that some of the long cross-country flights in the future may be made in this manner. The fact that well defined cold fronts may last for several days in traveling across the continent leads one to appreciate the possibilities there may be for distance flights in these great sources of soaring power. However, frontal soaring is a hazardous undertaking, which seems to have given way to cloud and thermal soaring as a means for improving distance performance. Of all the soaring manoeuvers, there is none so fascinating to the public, none requiring such skill and judgment on the part of the pilot, nor such ingenuity and care on the part of the designer, as a good cross-country flight in fair weather.

A typical summer day usually dawns with a clear sky, perhaps a haze on the horizon, and very little wind. As the sun rises in the sky, its heat will become more and more intense, thermals will be formed in the atmosphere, and light puffs of wind may frequently occur. By 10 A.M. cumulus clouds may begin to form in the sky, increasing in size and number until by one o'clock the sky will be dotted with them. As the afternoon progresses, the clouds will continue to form and float lazily across the sky. By late afternoon they will slowly fade away, and by sundown may have completely disappeared. The cumulus clouds denote typical soaring weather, and their appearance thrills the soaring pilot, and beckons him to be off for a cross-country jaunt.

If a flight to a definite goal some miles away is planned, and the weather forecast indicates that there will probably be cumulus clouds all along the proposed route, then the flight procedure is well defined, for the pilot has only to fly from cloud to cloud, gaining sufficient altitude on the one to enable him to glide to the next. The distance he may hope to attain before the cumulus clouds fade away in late afternoon will depend upon the hour of his start, and the speed with which his sailplane will fly. If, however, the conditions are such that he must fly over long stretches of terrain over which no clouds are forming, he will be forced to descend to a lower altitude and utilize ridge and thermal upcurrents alone.

The characteristics of the sailplane which will be able to travel the greatest distance under such conditions may now be described. The speed at which a sailplane flies most efficiently, i.e. at which its gliding angle is a minimum and it loses the least altitude per foot flown, depends upon the weight of the plane. A heavily loaded sailplane will fly more efficiently at a higher speed than if it were lightly loaded. It is therefore quite important that the plane be heavily loaded for cloud flying, for upon sighting a new cumulus in the process of growth some miles distant, the pilot must fly as quickly as possible to the site in order to make use of the upcurrent, which, as has been seen, may endure for only a few minutes.

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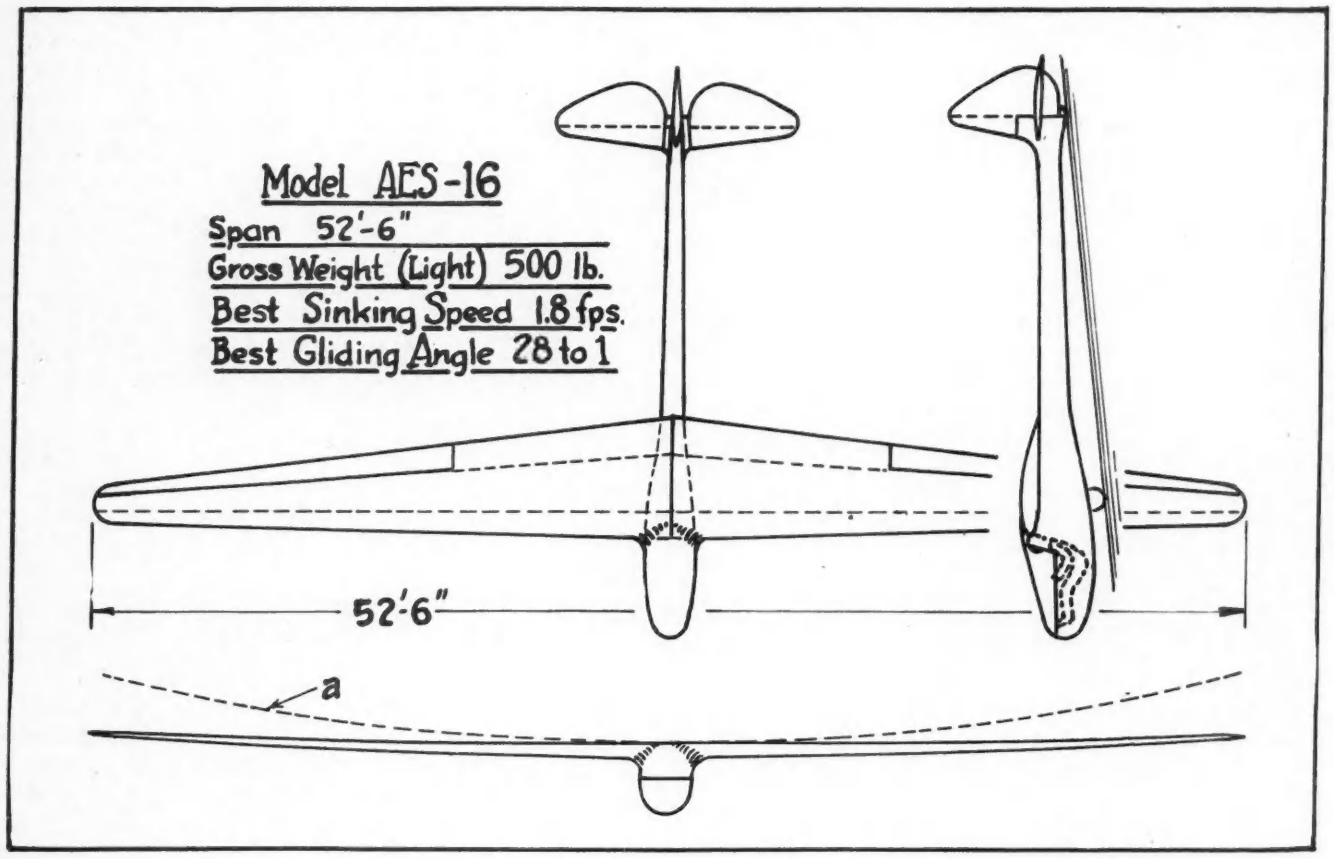

Fig. 4.

Cosmic Rays—

A MYSTERY OF THE UNIVERSE

—Unsolved

By RALPH D. BENNETT
Associate Professor of Electrical Engineering
Massachusetts Institute of Technology

THE wide scientific interest in the study of the cosmic radiation probably results from the fact that it presents a scientific puzzle of the first magnitude, particularly with regard to its nature and origin. It became evident early in this study that the energies involved were many orders of magnitude greater than those manifested in any previously known radiation. The possibility of putting these energies to economic use has been a great factor in making the subject of general interest to every one. However, it should be pointed out that the total energy which the earth receives from cosmic radiation is approximately equal to that of starlight. While this total is impressive, the intensity at any one location is so extremely small that it is improbable that it can ever be of direct use. The important fact is, that if we are able to understand and control the processes found in cosmic ray phenomena, we shall possibly make available new sources of tremendous energy.

The only method we have of detecting the presence of cosmic radiation lies in its ability to disrupt atoms of gas, resulting in the process known as ionization. Each ionizing process produces a pair of ions, one of the pair being positively charged and the other negatively. The positive ion is the core of the atom from which the electron has been dislodged, and the dislodged electron is the negative ion. The rays which produce ionization directly consist of fast-moving particles of which alpha- and beta-rays are common examples. Electromagnetic rays of the gamma-ray type also produce ionization, but indirectly. It is necessary that these rays first collide with an electron and impart their energy to it, after which it becomes a fast particle. Thus, if the cosmic rays are originally of the gamma-type, all their manifestations result from secondary rays, while, if they are of the particle type, it may be that we sometimes detect the primary rays themselves.

Three types of instruments have been developed for the detection of cosmic rays. While they all base their action on the process of ionization, their methods of operation are considerably different. The first type of instrument is known as an ionization chamber. It consists of an isolated mass of gas with two electrodes inserted, a means of producing a difference of potential between these electrodes, and a meter of some sort for measuring the current which flows in the resulting circuit. In any chamber of reasonable size the total ionization is extremely small, requiring a very sensitive instrument for measuring the resulting current. The effect can be increased by increasing the volume and pressure of gas and the size of the atoms which constitute it, but even with the biggest device of this sort in use at the present time the currents amount to only about 10^{-12} ampere. The current measured indicates the intensity of the cosmic radiation penetrating the chamber.

The second device for the detection of cosmic rays is known as the Geiger-Müller counter. In this the electrodes take the shape of concentric cylinders, the inner one being much smaller in diameter than the outer. The actuating potential for the Geiger-Müller counter is raised until it closely approaches that required for breakdown. When this condition obtains, the passage of an ionizing particle causes a spark to pass. The external circuit is arranged to interrupt the resulting current at once. Thus the Geiger-Müller counter is essentially a detector for the passage of a corpuscular ray.

A common method of using these counters is in banks of three, interconnected by means of vacuum tubes in such a way that only simultaneous pulses from the three counters are recorded. The counters are placed side by side with axes parallel and in the same plane, and spaced at distances of a few diameters from each other. With this arrangement there is a small solid angle common to all three, and linear rays coming from points in space which are included in the common solid angle may be expected to actuate all three counters nearly simultaneously. Such a combination constitutes a sort of telescope which can be pointed in certain directions in space to measure the frequency of arrival of rays from that direction.

The third instrument for the detection of cosmic rays is known as the Wilson cloud-expansion chamber. Its action is based on the well-known phenomenon of condensation of water droplets on ions in supersaturated gas. To control this phenomenon the moist gas is expanded to produce super-saturation and if, during the critical part of the expansion, an ionizing particle passes through the chamber, there is produced a track of white droplets which can easily be seen and photographed. The cloud-expansion chamber shows not only the direction of travel of the corpuscular ray, but from its density it is possible to draw inferences concerning the nature of the particle. If in addition the chamber is placed in a strong magnetic field, the velocity, charge, and mass of the particle can be determined.

The first evidence for the existence of cosmic radiation appeared in the early years of the present century from studies with ionization chambers. In the years 1910 to 1914 a considerable amount of evidence was gathered which pointed toward a source of this radiation external to the earth. However, it was not until 1926 that all of the workers in this field became convinced of the existence of the radiation and of its extremely great penetrating power.

Beginning with 1926 and extending down to the present, the absorbing power of water has been carefully studied. The resulting curve of intensity of radiation against depth of water shows without doubt that the radiation is not homogeneous, consisting of at least five components. The softest of these components is considerably more penetrating than the hardest radiation from radium. Theories have been advanced concerning the origin of the components in a synthesis of common celestial elements in intergalactic space, though these theories are not at present in high repute.

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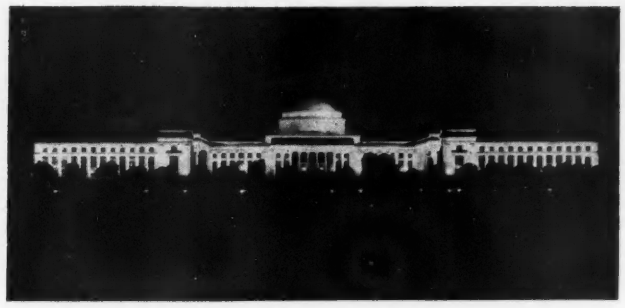
THE TECH ENGINEERING NEWS



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EDITORIALS

WHY HONORARY FRATERNITIES

SINCE the forming of Phi Beta Kappa in 1776, honorary fraternities have been forming and dissolving in great profusion. In true competitive spirit each course of learning has vied with the others in establishing Greek letter fraternities. Engineering rejoices in four or five national "societies". There has been an effort on the part of these societies to convince themselves and everyone else of their importance. Some upholders of these organizations "point with pride" to the fact that these societies consist of the masters in their respective fields. Others speak of the influence, the so-called "driving force" that these men have upon their fields of endeavor. This "driving force" they term the concentrated fraternal effort to develop their particular field. The real value of these societies is open to question. Are the motives of these organizations purely idealistic? Might there not be the taint of satisfied superiority? What are the true qualifications for obtaining entrance into the societies? Can the methods of selection be equitable and just?

A medical honorary society goes the Book of Revelation one better. Its letters are Alpha Omega Alpha. No doubt it boasts "I'm Alpha and Omega and Alpha all over again." The superior and exclusive feeling engendered by these fraternities preclude any co-operative desire to develop the field. Key men exhibit an unfortunate smug self-sufficiency. They gain by being of a society all the disadvantages of the clique.

As yet the requirements for members in these honor groups (their roster reads like a list of radio stations) are confined primarily to scholastic standing. It must be remembered that rank is established only by grades and thus the well-known shortcomings of the grading system are incorporated directly into the admission requirements of honorary clubs. It must be remembered that judgment on this basis is subject to human error from fallible data.

Furthermore, there remains the obvious point that the classroom record does not attempt to measure certain valuable qualities that leaders in any field will have to possess and so are not a true criterion for admission. Those characteristics usually termed under the heading "Salesmanship" are not considered. It has been said that technical education is only one of nine points in the evaluation of the engineer. One of these alone allows entrance to a society. There is no conclusive evidence to prove that the leaders of their professions are recognizable as such while still undergradu-

ates. On the contrary statistics tend to show that scholastic ranking has very little bearing on eventual success in the business world. Scholastic standing has never been considered the sole criterion for the establishment of any man as a master in his chosen field.

After all what can the key man actually open with his key. A few industries may show preference for honor society men, but in general the key will be unnoticed. Experience and ability are the keys to success. Another activity—another distinction—but only in the little domain of your particular school.

ADAPTATION

THE problem of where the old time industry will fit into the complexities of modern times is in some cases clearly unsolvable. The time-honored harness maker is doomed. Aside from recent fads the bicycle business has been constantly in decline. However, in the majority of cases ways can be found in which the old industry can fit. The blacksmith of twenty years ago has gradually transformed his shop into the modern forge plant.

The way in which the rosin industry has expanded and applied itself to modern uses makes an interesting illustration. "Thirty years ago rosin was produced by negro labor which tapped a tract of pine trees for pine gum and boiled the rosin out in ramshackled still-houses." Now whole trees including their stumps are shipped in carloads to modern plants where they are put through processes that yield not only rosin but such useful fluids as turpentine, pine oil, and various other rosinous products. If a carload of rosin were followed, we would find it put to a variety of uses. Barrels of rosin are used in foundry work. Mixed with sand it provides cohesion for molds into which molten iron is poured. In another field, quantities of rosin are now used to remove hog bristles. In slaughter houses, men apply rosin with paint brushes to freshly killed hogs. The rosin solidifies, and then it is scraped off carrying with it the bristles.

The way in which the rosin industry has geared itself up to meet modern demand has been and may be parallelled by many other industries. It is reasonable to believe that the majority of industries are perpetually secure and need only to be revamped from time to time and their products adapted to the market.

DESIGNING COLLEGE VACATIONS

THE Institute provides us with a total of a few days more than two weeks of freedom from the stress of study. During these periods, we are told to "let down" completely. These breathing spells are good to have, but they have their faults. The week before a vacation is usually marked by low scholarship, and the pale wan faces of the "let downers" during the week afterward are only too apparent. The change from study to blankness is too abrupt.

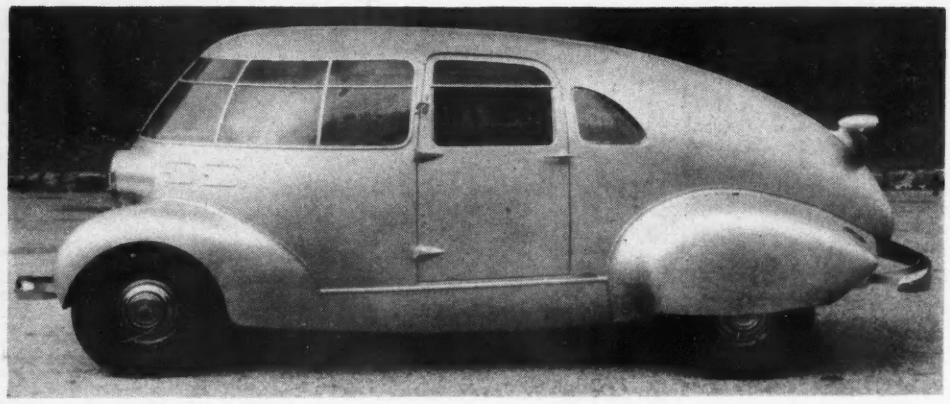
A few progressive institutions in the country are trying to work this problem out. In one in particular, study concentration is relaxed and spread quite evenly over the year. Starting with the holiday season, Bennington College, Vermont, places its students in various positions about the country at regular jobs. The students receive this practical experience during this time and obtain college credit. Instructors work side by side with students. During the term proper, classes and lectures are few. The minimum of college ordered schedule is demanded during the upper class years. There are no long vacations except during the summer, but the work is moderated by spreading it throughout the entire school year. Northeastern University in Boston also has a co-operative course in which the students work in industry five weeks and then attend classes for five weeks alternately.

Of course in contrast to the Institute, the Bennington College is virtually a co-operative school, but the fact that co-operative schools are becoming increasingly popular points to the consideration that perhaps their ideas are good. Sacrificing complete vacation for anything is hard to take, but nevertheless a better balance might be reached with moderation and vacation as variables.

ANNOUNCEMENT

The Managing Board takes pleasure in announcing the election of John K. Jacobs, '37 to the position of Managing Editor and Jervis C. Webb, '37 to the position of Associate Editor.

ENGINEERING DIGEST



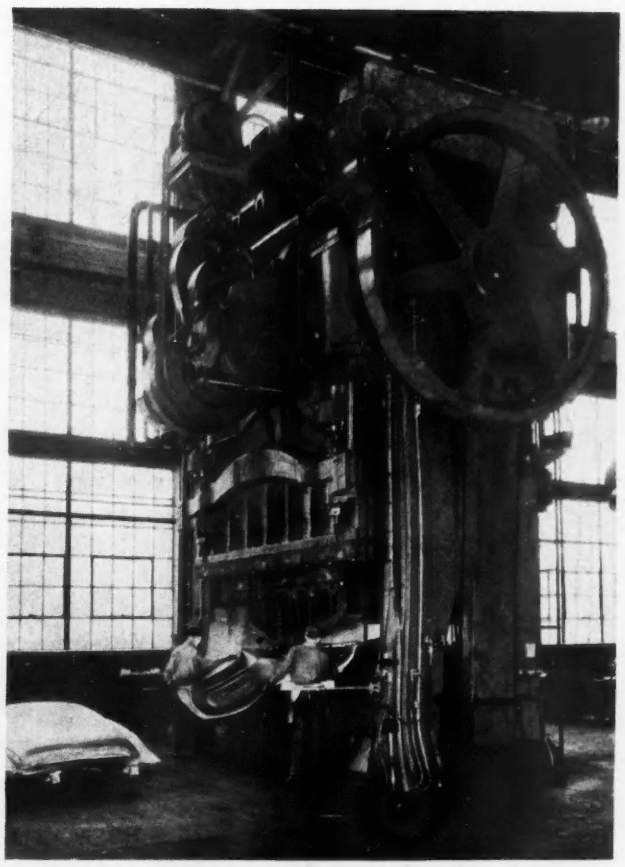
TEARDROP

One of a fleet of new "teardrop" design cars. The streamline body, mounted on a conventional Ford chassis, makes possible greater top speeds and eliminates the side sway that is so commonly noticeable in bodies of standard design. The adaptability of the new body to a standard chassis makes great economy possible, while its round transverse section affords a larger interior. — *Autobody Trimmer and Painter.*

TERMITES

TO drive the termites back into the forests from which they came and thus rid civilization of an organism that threatens to destroy many of its buildings several modes of attack are being carried out. One very effective method is the use of arsenical compounds which, however, are as poisonous to man as they are to the wood-boring insects. Coal-tar creosote is also effective but objects coated with it are rendered very unattractive. The best development to date is a refined creosote which does not alter the color of the wood and which permits the wood to be painted after treatment.

By way of explanation, termites are not ants. According to their habits they may be divided into two major types: wood-dwelling termites and earth-dwelling termites. Earth-dwelling termites are the more important in that they do more damage, attacking wood that is placed in or on the ground. Many wood structures are infested with termites that are rapidly destroying these structures. — *Electrical West.*



4,000,000 POUNDS

The new Fisher Turret all-steel tops are stamped out by presses which exert a force of nearly 4,000,000 pounds and weigh 500 tons. These presses are said to be the largest of their kind in the world.—*Motor.*

RESEARCH IN REVIEW

COURSE XVIII — Mathematics

FOR nearly a century it has been experimentally known to geographers that to color any map of a portion of the sphere in such a way that regions which are contiguous along a line have different colors, only four colors are necessary. The corresponding mathematical theorem has never been proved, and the problem is famous as the simplest unsolved mathematical problem, since its result is comprehensible to any kindergarten child who can count up to four.

It is known that four colors may be needed, and has been proved that five will always suffice. In attempting to prove this theorem, various configurations have been discovered such that the problem of coloring any map containing one can be reduced to that of some other map with fewer regions. For example, a single region surrounded by three others is a reducible configuration. At one time it was thought that the known configurations applied to most maps, and only a proof of their presence was needed. However, in his doctor's thesis on the four color problem (published in 1922), P. Franklin showed that with respect to all the reductions previously known, and some additional ones found by him, there were maps of as few as 42 regions which were not reducible. He showed that every map of 25 or fewer regions could be colored in four colors. Later (1927), C. N. Reynolds, Jr. proved that the number 25 could be replaced by 27, but not by any larger number without additional reductions. No significant progress has been made since this time.

It is curious that if the map is drawn on an anchor ring, or surface like this with more than one hole, the problem of coloring maps may be solved in many cases. Thus, for the anchor ring, seven colors are sometimes needed, and are always sufficient. A recent paper of P. Franklin solved the problem for the "one-sided" surface related to the anchor ring. For this surface six colors are needed and always suffice. It is curious that, if five colors are used, all maps with the exception of one are reducible.

COURSE II — Mechanical Engineering

SINCE all textile fibres are polarizers of light, recent work in the textile microscopy laboratory has centered about investigation of this phenomenon, and the work has been productive of several discoveries of immediate practical importance to the textile industry.

The maturity of the cotton fibre is an important property which affects the spinning and finishing qualities of the yarns and fabrics made from it. The colors produced in cotton fibres when properly viewed by polarized light in the microscope are a certain indication of maturity and a technique has been developed which enables the mill-man to measure the maturity of the cotton which he buys in a matter of only a few minutes.

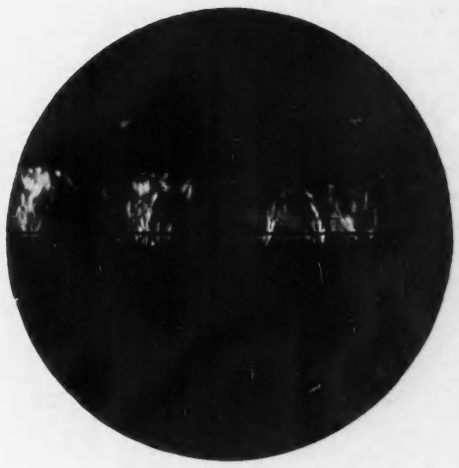
Further, it has been established that the molecular orientation of fibre structure has an important bearing upon the strength and the dyeing properties of fibres—particularly the synthetic filaments. Determination of the changes in the specific index of birefringence is pointing the way to improved rayon, and is making plainer the complicated structure of many of the natural fibres.

COURSE VIII — Physics

ONE of the most striking research projects of the department is Professor Stockbarger's crystallization of lithium fluoride. A very difficult substance to crystallize, and not occurring in natural crystals, it is transparent further into the ultraviolet than any other known substance, and would be invaluable for lenses, prisms, and windows for ultraviolet optical equipment. By a new cooling technique from the melt, Stockbarger has succeeded in growing two and three inch crystals of perfect optical properties, finer than any previously produced.

The great excitement in physics these days in all parts of the world is in the study of the atomic nucleus, radioactivity, induced radioactivity (almost any element, it has been discovered in the last year, can be made radioactive by bombardment with suitable high-speed particles), the high voltage production of high speed particles, and cosmic rays. It is in this field that Professor Van de Graaff's high voltage research lies. Two other projects in the related fields have been conspicuous at the Institute this year. Professor Evans, newly come from the University of California and California Institute of Technology, is starting a program of research in radioactivity, particularly in application to the problem of the determination of the age of the earth from the radioactive content of rocks. And Professor Vallarta, in collaboration with the distinguished Belgian astro-physicist Abbé Lemaitre (Ph.D., M. I. T., Course VIII, 1927), has been carrying further his theory of the deflection of the charged particles of the cosmic rays by the earth's field.

Theoretical physics of a less striking but nevertheless important nature is represented by the development of spheroidal wave functions by Professors Stratton and Morse. They have attacked the purely mathematical problem of solving the wave equation in ellipsoidal co-ordinates, of tabulating the previously unknown functions which result from the solution, and of investigating their properties. Different problems as radiation from an antenna, propagation of sound from a hyperboloidal horn, scattering of light by elongated particles, and scattering of electrons by diatomic molecules can now be solved satisfactorily.



Ramie fiber, parallel position in polarized light.

HEAT

Continued from Page 27

rotating mechanism but it failed and the temperature inside finally rose to 104° F. He actually suffered from the heat, although surrounded by frigid temperatures.

As it is apparently easier to protect one's self from cold than from heat in stratosphere flights, the present practice provides against excessive heat by painting the upper portion of the gondola white and the lower portion black. In the account of the National Geographic Society expedition to the stratosphere in the summer of 1934, there was mention of ice formed on the upper inside of the gondola which was exposed to solar radiation while the lower portion of the gondola felt relatively warm due to absorption of heat from the earth and lower atmosphere. House heating in the stratosphere would be a very simple problem during the day time, despite the extreme low temperatures, as any desired temperature could be produced in accordance with the color of paint used on the side facing the sun. The solar radiation per square foot in the stratosphere is much greater than that of a steam heated plate, one square foot in area, in a room at 70° F.

For over a century, it has been well known that bright metals are poor radiators of heat at room temperatures and in laboratories all over the world, it has been common practice to reduce heat losses from calorimeters, etc., by the use of brightly polished metallic surfaces.

In the well known vacuum bottle invented by Dewar, the transfer of heat was reduced by evacuating the space between the two walls of the vessel, thus practically eliminating conduction and convection of heat, but it was also found that the heat loss by radiation between the two walls must be minimized by silvering the inner surfaces before a first class insulating container was produced. In a commercial bottle of this type with a space of 3/8" between the walls, proper silvering of the surfaces to prevent radiation is a more important factor than the evacuation as far as heat transfer is concerned at room temperatures.

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The importance of radiation of heat at room temperatures is frequently not realized by the designer of equipment which is losing or gaining heat from its surroundings. For example, a bright tin duct from a warm air furnace will not lose as much heat as the same duct covered with one or two layers of asbestos paper because asbestos paper is a good radiator of heat compared with the bright metal. The insulating value of one or two layers of paper is not sufficient to make up for the difference in radiating power of the two surfaces.

In the typical house wall of frame construction, there is an air space between the studs approximately 3¾ inches wide. Heat is transferred across this space by radiation and convection. The radiation between the plaster wall on one side and the wood sheathing on the other is responsible for more than 50% of the total transfer of heat. More than 60 years ago, Peclet, the French scientist who wrote a classic treatise on heat, performed a number of experiments on insulation by means of bright metal sheets and found that, although a number of bright tin plates, suitably spaced, afforded excellent insulation, the method was impractical because of the cost. It was not until about 1925 that Prof. Schmidt utilized this principle in developing a commercial form of insulation using thin aluminum foil for heat-reflecting surfaces. In the frame wall mentioned above, a single sheet of aluminum foil, 0.00045 inches thick, placed in the middle of the air space will reduce the heat loss through the wall by approximately 40%.

The proposed system of heating our homes with heated walls is another application of low temperature radiation. If one is surrounded by walls at a temperature of 80° F., he will be comfortable with much lower air temperatures than if the walls are at 60° F. primarily because of the smaller amount of heat lost by radiation between the walls and the body.

Within the past few months there has been placed on the market a heat-reflecting wall paper consisting of suitably embossed aluminum foil attached to paper and heat-reflecting window shades composed of aluminum ribbon woven like cloth which are designed to prevent the excessive heating of a room by solar radiation.

Only a few of the applications of heat radiation have been mentioned and there are undoubtedly many others. With increased knowledge of radiation phenomena, I believe that the prevention of heat transfer by retarding radiation will be an increasingly important method especially at relatively low temperatures. It is also possible that both solar radiation and cooling by radiation may be used to better advantage in the future.

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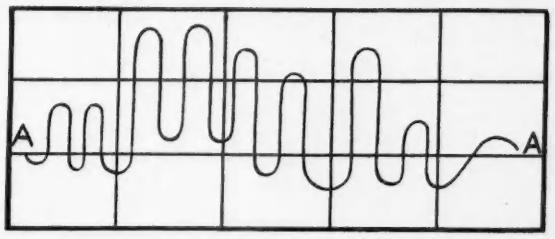

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GLIDER

Continued from Page 30

On the other hand, the minimum sinking speed of a sailplane increases with the weight of the plane. So in order to soar on upcurrents of low intensity, the plane should be light. The upcurrent in thermals may be as low as five feet per second, necessitating a much lower sinking speed for the sailplane, in order to gain altitude.

These two contradictory design requirements are both quite necessary in order to enable the sailplane to fly furthest, using both cumulus clouds and dry thermol. For in the clouded sections of the route, high speed and therefore a heavily loaded plane are important, whereas in the cloudless stretches, where dry thermals and ridge currents will provide the only means of passage, a minimum sinking speed may be still more important, necessitating a light loading.

A means which somewhat improves the distance performance under such conditions is to equip the sailplane with a ballast tank capable of holding, for a normal plane, about 100 pounds of water. Thus equipped, the plane starting a flight with good cloud conditions and a full ballast tank will have the necessary speed for efficient cloud flying. If at any time the cumulus clouds disappear enroute, and the pilot is forced to utilize upcurrents of less intensity, he has only to release the water from the ballast tank to reduce his sinking speed to a minimum. Once having emptied the tank, the efficiency of the plane for further cloud flying will be somewhat impaired, so the pilot must judge the relative importance of low sinking speed, before releasing the ballast. Thus it is seen that a ballast tank acts as a reserve source of power, so to speak, which the pilot may use without expense in the clouded stretches.

The proposed sailplane Model AES-16, designed for the Aeronautical Engineering Society of the Massachusetts Institute of Technology by Ray P. Holland, Jr., '34, and the author, is an attempt to combine, in a single sailplane, the necessary characteristics for all types of soaring. It is planned that the student members of the A.E.S. will build and fly this model, and although the actual construction work has not yet begun, many of the preliminary details are being carried out under the able direction of Richard Koegler, '36.

As shown in Fig. 4, Model 16 has a wing span of 52½ feet. The wing is full cantilever, and is designed to develop the requisite strength with as thin a wing section as possible. An amusing detail is that the wing may deflect to the position (a) before failure. This position corresponds to a load factor of ten, which is amply strong for severe flying conditions. The streamlined fuselage and well filleted wing denote the care which is taken to reduce the air resistance of all parts of the sailplane. Control horns are enclosed, and the single wheel landing gear is retracted into the fuselage after the take-off.

Performance calculations made in airplane design need to be taken "with a grain of salt", and should be proven by actual flight test results. But the calculated minimum sinking speed of Model 16 is 1.8 feet per second, making it possible to climb at a rate of almost 200 feet per minute in an upcurrent of only five feet per second. This fact should insure good performance as a thermal soarer. The calculated gliding ratio is 28 to 1, which will enable the plane to glide 28 miles from an altitude of one mile, and therefore to fly from cloud to cloud without too great a loss in altitude.

The stability characteristics have been carefully checked, so the pilot need have little fear of flying blind within a cloud. The installation of wing flaps will make the plane easy to land in small fields. At present an extensive stress analysis is being made to insure adequate strength of all parts of the structure.

The actual construction work on Model 16 at present awaits the necessary finances, a statement which will bring a smile to the face of many old grads, who are acquainted with the activities of the Society, and know of the many gliders built and flown by these staunch enthusiasts, and of their earnest effort to promote the sport of gliding and soaring at the Institute.

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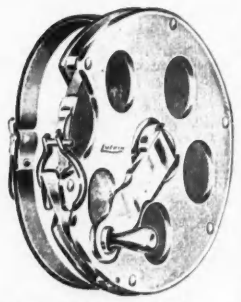

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COSMIC RAYS

Continued from Page 31

In 1928 an experiment was made which gave important evidence concerning the nature of the primary radiation. At this time the primary radiation was believed to be of the electromagnetic wave type. The extensive measurements on the absorbing power of water for the radiation had been made with this point of view in mind. The entity which was believed to cause the absorption was the electron, and the absorbing power of other materials could be estimated by comparing the total number of electrons in these materials with the total number in an equivalent volume of water. The absorption coefficients so derived were believed to apply only to the primary electromagnetic radiation. In 1928 Bothe and Geiger, by means of two Geiger-Müller counters, measured the absorbing power of gold for the rays which actuated the counters. These rays had, heretofore, been assumed to be secondary and much less energetic than the primary radiation. However, this experiment indicated that the corpuscular rays were just as energetic and just as penetrating as the primary radiation, in fact that the primary radiation is corpuscular.

A crucial test to determine whether the radiation was corpuscular or electromagnetic could be made by passing the rays through a magnetic field and observing whether or not they were deflected. The magnetic field would deflect positively charged particles in one direction, negatively charged particles in the opposite direction, and electromagnetic waves not at all. Because of the great velocity and energy of the particles a very extensive or very intense magnetic field is necessary for this experiment. Fortunately, the earth provides an extensive magnetic field, and the test consisted in measuring the cosmic ray intensity at various points on the surface of the earth. During 1932 and extending down to the present time, measurements have been made at nearly a hundred different stations. The results of these measurements indicate a minimum of intensity at the magnetic equator and a constant intensity beyond about 45° from the magnetic equator. This result is believed to prove beyond doubt that at least a considerable portion of the primary radiation consists of charged particles.

Professor Vallarta, of the Institute, working with Abbé Lemaitre, has evolved a theory correlating the results of these measurements. This theory further indicates that a measurement of the direction of maximum intensity in the low-intensity equatorial belt would show whether the particles were predominantly negatively charged or predominantly positively charged. An experiment to test this theory consisted of placing a Geiger counter telescope in a vertical east and west plane and measuring intensities at equal angles from the vertical both toward the west and toward the east. If the corpuscular particle were mostly positively charged, then more rays would be received from angles west of the vertical than from corresponding angles east of the vertical. Such an experiment was made by Dr. T. H. Johnson, of the Bartol Foundation, in 1933, with a result indicating that the primary radiation is predominantly positively charged.

The Vallarta-Lemaitre theory also predicts a north-south asymmetry in the transition band between the equatorial and temperate regions. Dr. Johnson and Professor Vallarta found such a north-south asymmetry near Mexico City in 1934. From the variation of these asymmetries, with elevation above sea level, it has been possible to show that probably all of the radiation is corpuscular, that most of it is positively charged, and that the primary particles may well consist of positrons, protons and some alpha particles.

Since work began in the field of cosmic rays, attempts have been made to correlate fluctuations in intensity with solar or sidereal time in an effort to locate the source of the radiation in space. All observers have found fluctuations and many of them have found such correlations, but few agree regarding the details. To settle this question the Carnegie Institution of Washington has sponsored the construction of seven large intensity meters under the direction of Professor A. H. Compton at the University of Chicago.

Ever since sensitive instruments have been available for the study of cosmic rays, observers have noted occasional violent localized increases in intensity. The nature of the resulting bursts of ionization indicates that very large numbers of rays pass through the apparatus simultaneously. The biggest burst of this nature so far recorded involved the simultaneous production of over a billion ion pairs and probably resulted from the passage of more than 5,000 particles through the chamber simultaneously. Such a burst could not result from the total disruption of any atom since no known atom contains so many elementary particles. From our present information regarding atomic and nuclear structure it is improbable that such a burst results from the interaction of adjacent atoms.

Many Technology people have been occupied in the study of cosmic rays. E. H. Bramhall ('28), W. P. Overbeck ('34), C. A. Hedberg ('36) and the writer assisted in the 1932 survey. Henry A. Rahmel ('34), G. S. Brown (staff) and the writer tested the first of the new Carnegie Institution meters in Colorado in 1934. Professor Vallarta has been influential in producing the soundest theory yet brought forward concerning the nature of cosmic rays.

There is no doubt that the quest for the origin of cosmic rays will continue to be pursued vigorously by many scientists. In this connection it might be mentioned that the origin may have to be sought in time as well as in space, since if the cosmic radiation had been created at the same time as the solar system because of its great penetrating power more than 90% of it would still be coursing through space. The usefulness of the radiation, as I have already indicated, will probably not come directly because of its very small total energy, but its study may show us processes which we can reproduce under controlled conditions to give us great sources of energy.

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By **W. B. MILLER***

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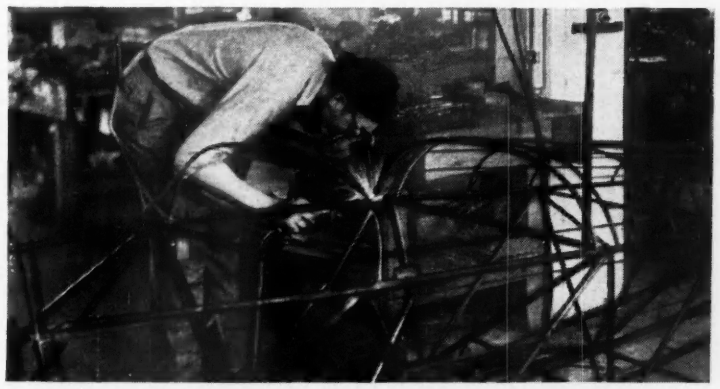


STRONG JOINTS—95 per cent of all aircraft have oxy-acetylene welded fuselages, wings and other members.

admirably suited for piping or containers of any sort, to resist pressure, temperature, or shock. Another way of making the product stronger is to weld it from one of the new alloy steels or strong non-ferrous alloys. In this way another desirable property is usually obtained — lighter weight. Welding can be used to make joints in any of the commercial metals.

In Aircraft Construction

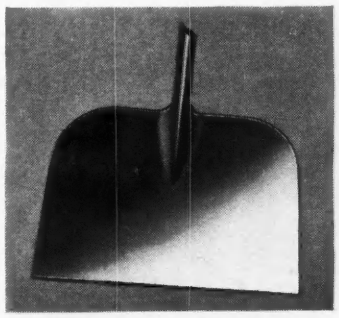
Outstanding as an example of the use of welded joints for their strength is in aircraft manufacture. In an airplane fuselage, every joint must be strong enough to withstand heavy stresses from all sides in flying. The joints must be tough also, for the shocks they undergo are sudden as well as powerful. They are made in a strong alloy—chrome-molybdenum steel. Welded joints are the standard of the aircraft industry because they fulfill faithfully these essential requirements on which so many human lives depend.

For Rigorous Use

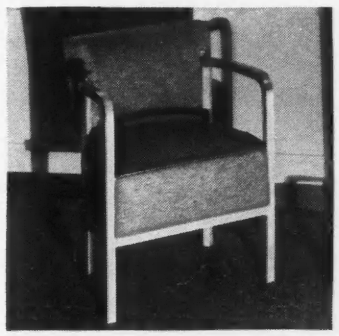
For years, field hoes were manufactured by a forging and rolling process involving a considerable investment in machinery. An enterprising hoe manufacturer found that he could eliminate inherent weaknesses by welding. He designed a bimetal job: the hoe blade of a steel made to hold its cutting edge longer, the sturdy shank of a steel selected for its ability to withstand shock and fatigue. These are then joined by welding with a bronze welding rod. In this way there is no compromise—materials are chosen for the job they are to do—and the manufacturer makes a better hoe at lower cost.

In Modern Furniture

In making metal chairs it is necessary to get a strong ductile joint and one smooth in contour to take the various special finishes which are applied to simulate wood. The strength of joints made with special high strength welding rod can



SIMPLE—by adopting welding for these field hoes, the manufacturer produces a product with none of the disadvantages of older designs.



TRIM JOINTS—for metal furniture are made by welding. Chairs of welded metal easily support as many heavyweights as can hang on.

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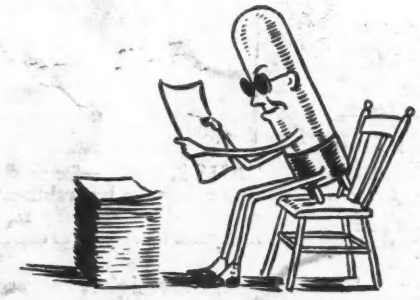


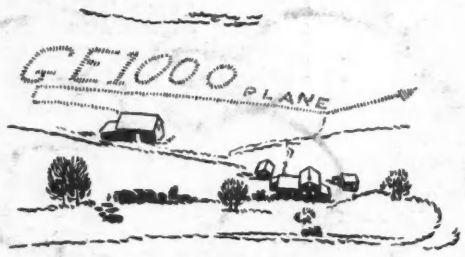
GLASSES FOR ELECTRIC EYES

Electric eyes are wearing colored glasses and doing a new job. As a result of strict NRA code requirements, the paper industry had to find a rigid means of classifying different qualities of paper. The Institute of Paper Chemistry found that as far as white book papers were concerned, the percentage of light they reflected was an indication of their quality.

The General Electric general engineering laboratory built the necessary device—an instrument which relies on the scrutiny of two phototubes in series to measure the coefficient of reflection. This is an exceedingly delicate task, as the matter of a small percentage of reflectivity determines the price and quality of a paper.

Here's where the glasses come in. To do certain jobs right, the electric eyes had to don different colored glass screens in the form of a filter and lens arrangement. It wasn't that they were getting old; they just needed a little assistance.

J. L. Michaelson, Northwest Missouri State Teachers College, '28, is G-E engineer in charge of building these instruments.



"GE-1000"

When, after a two-day search, a rescue plane finally located the lost transport plane which "mushed down" on a lonely Adirondack peak a couple of months ago, General Electric radio engineers rushed an emergency portable short-wave radio station into the mountain country to help in co-ordinating land and air rescue operations. The disabled ship was in the center of a wilderness, miles from the nearest means of communication. The radio expedition, however, managed to set up its equipment in a cabin at the end of a one-track automobile trail, only four miles from the scene of the mishap. There, designated as station "GE-1000" at the request of the airline operators, the equipment was used as an emergency unit in the airline's radio system. The General Electric engineers co-operated in communicating with the planes that guided the rescue parties toward the stranded fliers. They also helped send back news of the rescue, directly to owners of short-wave receiving sets, and through a rebroadcast by WGY, the General Electric station at Schenectady, to other listeners.

W. J. Purcell, chief engineer of WGY; W. R. David, U. of Kentucky, '19; E. H. Fritschel, Iowa State, '26; G. W. Fyler, Yale, '29; R. H. Williamson, Iowa State, '28; R. W. Orth, Minnesota, '30; G. M. Brown, Washington State, '29; and R. A. Lash, Ohio Northern, '29, comprised the General Electric radio expedition.

TURBINE BIOGRAPHY

A turbine can now write its own biography, with the aid of recording instruments recently developed in the General Electric general engineering laboratory.

These sensitive devices were developed for the supervision of large turbines from a point remote from the scene of operation. The instruments measure and record shaft eccentricity, bearing vibration, shell expansion, and interference of rubbing or rotating parts. They provide the operator with an indication and a permanent record, on paper, of mechanical performance throughout the starting period and subsequent running time.

C. D. Greentree, Alabama Poly, '28; A. V. Mershon, Pratt Institute, '13; and M. S. Mead, Case School of Applied Science, '23, of the General Electric general engineering laboratory, worked on the instruments.

96-130DH

GENERAL ELECTRIC

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